Differences between demersal fisheries discards: high and low productivity zones of the Northwestern Mediterranean Sea

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Differences in fishery demersal discards in low and high productive marine ecosystems in the North-western Mediterranean were studied. Analyses were carried in three common fishing tactics carried out in different habitats from coastal to slope bottoms. Though clearly out of date (1996-2000 years), data remain useful when formulating comparisons, and simultaneously establishing a temporal reference values of trawling fishing impact. Results revealed discards were strongly positively correlated with the biomass harvested. In the higher productive zone, in Northern Catalonia, discards varied significantly with the season of the year, whereas in the low productive zone, in the Balearic Islands, discards depend on the characteristics of the biocenosis of the bottom substratum. In the coastal and shelf fisheries, the highest average biomass for retained and discards catches were recorded in spring and summer in Northern Catalonia and autumn and winter in the Balearic Islands. In the slope fishery the maximums were recorded in spring in Northern Catalonia and autumn in the Balearic Islands. By fishing tactic and zone, in the Northern Catalonia discards for coastal and shelf were mainly of fish (44 ± 25 % and 25 ± 12% respectively). This concurs with the fact that in northern Catalonia bigger quantities of pelagic and epi-benthopelagic species with seasonal fluctuations increase in spring and summer. In contrast, in the coastal Balearic fishery discards are more balanced and mainly composed by flora and invertebrate fauna. In the shelf fishery of Balearic Islands, fish represented the higher proportion of discards (49 ± 13%). For slope fishery (28± 17% Balearic Islands and 22± 14% Northern Catalonia) discards were foremost due to species without commercial value and by-catch fish species of small size. Differences between biotic and abiotic factors have demonstrate importance in discards impacts and are key factors to understand how can be reduced discards. By delimiting areas of complex biocenoses structures and fish recruitment zones, as well sensitive seasons in what discards increases, as accuracy as possible, may allow a new management scenario adapted to each zone of reduced discards.
Keywords: *Discards, trawl fishing impact, biodiversity, Northwestern Mediterranean Sea.*

DIFERÈNCIES EN ELS REBUIGS DE LES PESQUES DEMERSALS PER HÀBITAT: COMPARACIÓ ENTRE ZONES AMB ALTA I BAIXA PRODUCTIVITAT EN EL NORDOEST DE LA MAR MEDITERRÁNIA. S'han avaluat les diferències en el rebuig pesquer demersal a ecosistemes marins d'alta i baixa productivitat en el Mediterrani nord occidental. Les anàlisis es varen dur a terme per tres tàctiques pesqueres comunes, realitzades a diferents tipus d'hàbitats des de la zona costera fins al talús. Encara que les dades són clarament antigues (1996-2000 anys), continuen vigents per formular compa-

racions i donar a conèixer valors de referència del rebuig i l'impacte pesquer a la Mediterrània nord-occidental. Els resultats mostren que el rebuig està positivament correlacionat amb la biomassa capturada. A la zona més productiva, a Catalunya nord, l'estacionalitat influencià significativament el rebuig, mentre que a les Illes Balears, el rebuig depèn de les característiques de la biocenosi dels substrats a on es pesca. A les pesqueres costera i de plataforma, les majors biomasses promig tant per la fracció retinguda com per al rebuig es varen registrar a la primavera i l'estiu a Catalunya nord i a la tardor i l' hivern a les Illes Balears. Per a la pesquera de talús els màxims es registraren a la primavera per a la Catalunya nord i a la tardor per a les Illes Balears. Per tàctica pesquera, a la Catalunya nord el rebuig coster i de plataforma va ser principalment de peix (44 ± 25 % and 25± 12%). Això coincideix amb el fet que majors quantitats de peixos pelàgics, i bentopelàgics d'espècies amb fluctuacions estacionals augmenten a la primavera i estiu. En contrast, a les Illes Balears, el rebuig coster va ser més equilibrat al llarg de l'any i compost principalment per flora i fauna d'invertebrats. A la pesquera de plataforma a les illes Balears, el peix va representar la major proporció rebutjada (49 ± 13%). Per a la pesquera del talús (28± 17% Illes Balears i 22± 14% Catalunya nord) el rebuig va ser principalment d'espècies sense valor comercial i talles petites d' espècies del by-catch de peixos. Les diferències entre els factors biòtics i abiòtics, han demostrat tenir importància en l'impacte del rebuig i són factors clau per entendre com es pot reduir el rebuig. La delimitació de zones de estructures de biocenosis complexes i també de zones de concentració de juvenils de peixos, com delimitació de períodes més sensibles a augments de rebuig, tan acuradament com sigui possible, ens permetrà definir un nou escenari de gestió de la pesquera demersal amb rebuig reduït.
Paraules clau: *rebuigs, impacte pesquer, biodiversitat, Mar Mediterrània nordoccidental.*

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Introduction

Fishery discards and by-catch information have gained importance in assessing the impact of fishing and in fisheries management (Hobday *et al*., 2011). Quantitative descriptions of size and species composition, and biodiversity based on catch rates have recently become a major tool to reflect how underlying factors impact on fishing (Murawski *et al*., 2010).

Fishing activity affects epibenthic communities in many different ways. Fishing acts as a predator, altering mortality and indiscriminately affecting both target and non-target species. Fishing increases mortality of juveniles (Bianchi *et al*., 2000), modify demographic structure (Stenseth and Rouyer, 2008), alter predator-prey interaction and competiveness (Blanchard, 2001) and trophic webs (Hooper *et al*., 2005). In this context, discards, the part of the catch that is returned to the sea, represent a waste of the sea marine production. Depending on the dynamics of each fishery, there is a wide range of discards due to the different properties of biodiversity and productivity in each zone

(Carbonell *et al*., 1998; Machias *et al*., 2001; Mallol, 2005).

For Western and Eastern Mediterranean discards fluctuated between 20% to 70% of the total catch (including flora) according to area and fishing tactic (Carbonell *et al*., 1998; Machias *et al*., 2001; Mallol, 2005). Discards vary widely by species according to the dynamics and species characteristics (biological cycle, sizes, fecundity, abundance, densities, etc.). Discards, both quantitatively and qualitatively, should be evaluated per fishing tactic in order to elucidate the factors determining the causes of discards. Species abundance and assemblages fluctuate at various scales in responses of changes in physical and biological processes, and these fluctuations produce variation in discards rates. A comprehensive analysis and a comparison of fishing discards in different zones linking the environment and biological process to the impact of fishing may help to develop new management schemes.

This paper presents two case-studies of the Northwestern Mediterranean focussing on biomass, abundance, and biodiversity measures of both retained and discarded fractions from one recognized oligotrophic temperate area, the Balearic Islands (Jansà *et al*., 1998), and from a productive upwelling system off Northern Catalonia (Boucher *et al*., 1987; Estrada and Margalef, 1988). These two studies were carried out in the mid and late nineties, without overlapping periods at a time when the fishing effort was higher (Rochet *et al*., 2010), decreasing thereafter from the mid nineties due to incentives for the decommissioning of boats. Gross tonnage control in the Mediterranean trawler fleets was established, albeit unsuccessfully, as the main management regulation tool. Though clearly out of date, these data remain useful when formulating comparisons, whilst simultaneously establishing a temporal reference in trawler fishing impact.

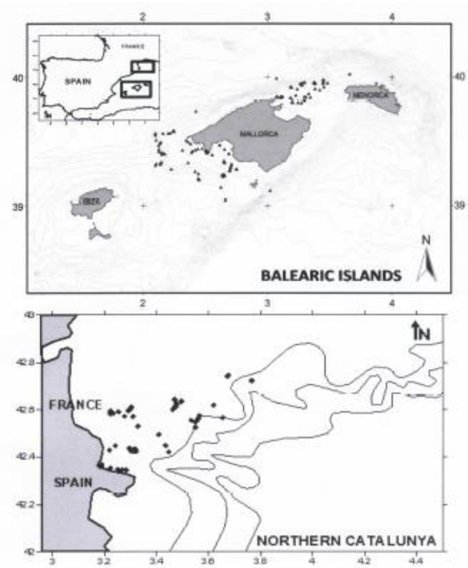


Fig. 1. Map of studied zones.
Fig. 1. *Mapa de les zones estudiades.*

Material and Methods

Study areas and data collection

The study was conducted in the Northwestern Mediterranean (Fig 1, Table 1) in the Balearic Islands (hereafter named BI) and Northern Catalonia (hereafter named NC). The fleets studied were similar in number, boat length, and engine horse power (28 Majorcan (BI) and 26 NC boats). Vessel lengths ranged between 16 and 24 m, and the corresponding fishing gear was a trawl net between 60 and 100 m with a vertical opening ranging from 1 to 3 m. The trawls had diamond net cod-ends of 40 mm mesh opening and were rigged with two doors between 200 and 500 kg. Fishing activity involves daily trips in the proximity of harbours. However, in NC, the shelf width and inclement weather hindered fishing over the slope, which was subsequently less sampled.

Fishing tactics were depth-stratified in both zones, which is the major factor in the structuring marine communities and target species. Discard sampling periods studied were between March 1994 and September 1996 for BI and between March 1998 and March 2000 for NC. Sampling was carried out by observers on-board commercial trawlers. All sampling activities were conducted without impeding or obstructing any of the crew's tasks. A stratified random sampling design was used. The sampling protocol was developed in accordance with ICES protocols (Pérez *et al.*, 1996; ICES, 1999) and is comparable to the EC data collection regulation (DCR EC No 1543/2000). Discards in this study follow the flora-exclusive FAO definition (1996). Data gathered include: fishing ground location, haul duration, catch in numbers and weight by species sorted into commercialized and discarded fractions. Once decked, the haul was sampled during sorting into commercial and discarded categories to obtain data on weight and number.

Data procedure and statistical analysis

Data on catch species composition per haul were standardized to hourly yields as a proxy for biomass ($kg\cdot h^{-1}$) and abundance ($N\cdot h^{-1}$). Ninety per cent of the trawl fishery was represented by three fishing tactics: "coastal ", "shelf and shelf-break (hereafter named shelf)", and "slope". The remainder tactics are a combination of the former, their importance was very low in the period studied and not considered for the study.

Catch and discard by biomass and abundance of species caught by different fishing tactics were studied according to the following categories: a) target species: defined as the objective for the fishery due to their commercial value and fished with significant profitable yields (defined in this study as up to 5 $kg\cdot h^{-1}$ for fishes and crustaceans, with null or generally low discards); b) common by-catch: species common to both zones, fished in significant quantities and landed with the target species, partially discarded or common species completely discarded; and c) uncommon by-catch: fraction of the catch, fished in significant quantities in each zone, landed with the target species, but partially or completely discarded.

	Balearic Islands (GSA 5)			**Gulf of Lions (GSA 7)**		
Latitude	37.1782º N	40.1016º N		43.1000º N	42.7000º N	
Longitude	2.0000º E	3.5106º E		2.4400º E	4.3000º E	
Years	1994-1996			1998 -2000		
Depth (m)	50 - 161.98	63.70 - 364	374 - 787	50 - 150	90 - 415	300 - 600
Mesh size	40 mm			40 mm		
Assemblages	Coastal	Shelf	Slope	Coastal	Shelf	Slope
Num. hauls	49	39	40	46	17	5
Weight (kg)	7211.05	3616.63	952.15	23115.05	5254.12	485.93
N	46818	73214	18107	842067	202900	11508

Table 1. Sampling effort by zone Balearic Islands and Northern Catalonia. No hauls (Number of hauls sampled); Weight kg= Sampling weight; N (Number of individuals sampled).
Taula 1. *Esforç de mostreig a les zones de les Illes Balears i el Nord de Catalunya. Num. Hauls (nombre de calades); Weight kg= massa captures; N (nombre d'individus mostrejats).*

The univariate community descriptors of each species were average biomass ($kg \cdot h^{-1}$) and abundance ($N \cdot h^{-1}$) with their respective coefficient of variation (CV) from mean and standard error estimated by the statistical resampling bootstrap technique (Efron and Tibshirani, 1993). Analyses were performed using the R computing programme (R Development Core Team, 2010), and the discard ratio was estimated as a percentage of the total catch of each species.

Species composition: biodiversity indices and trophic level

Species data were analyzed by conversion into various calculated biodiversity indices split into: 1) Number of species: richness of species (S) and Margalef's richness index (d) (Margalef, 1968). 2) Heterogeneous indices combining richness and evenness properties: Shannon-Wiener biodiversity index ($H'log_e$) (Shannon, 1948), Pielou's evenness index (J') (Pielou, 1975), Simpson's index (Simpson, 1949). 3) Taxonomic biodiversity indices sensitive to hierarchical community structure: taxonomic distinctiveness Δ^* quantitative data and average taxonomic biodiversity Δ^+ presence/absence data (Warwick and Clarke, 2001). The estimations were made using the set of all species identified in each fishing tactic. Indices were calculated for each sample, and mean values for each fishing tactic and zone were calculated. Comparisons of indices were made between each fishing tactic and zone by means of Spearman's rank correlation matrix (Merigot *et al.*, 2007).

k-dominance abundance-biomass curves (ABC curves) by fishing tactic were investigated for significant differences in the dominance patterns of fishing impact in each area (Warwick and Clarke, 1994). All analyses were performed using PRIMER v 6.1 analytical package (Clarke and Gorley, 2006).

Stable isotope analysis to estimate the mean trophic levels of the 25 more abundant species per fishing tactic were calculated. Trophic level (TL) values for each species were obtained from the data gathered by Pinnegar *et al.*(2003) for the Western Mediterranean.

Data were weighted to the average yield and abundance values of species, and summed up to calculate the mean trophic yields and abundances and their correspondent standard deviation (SD). We assignned level 2 for the unknown trophic level of invertebrate species (mainly feeders and grazers).

Seasonal analysis of the retained and discarded yields

A redundancy analysis (RDA) based on the correlation matrix enabled the partition of the variation of response variables of interest as lineal combinations of a subset of explanatory variables summarized by the depth vector as an overall depth vertical structured variable; season as a measure of intra-annual variability, the North Atlantic Oscillation (NAO) seasonal index (Hurrell, 1995) as an overall climatic influence throughout the period studied; the Shannon species biodiversity (H) as a vector synthesizing species richness; the Taxonomic distinc-tiveness (D) as a measure of complexity of biocenoses structures; and total biomass ($kg \cdot h^{-1}$) as a measure of ecosystem productivity. Analysis were performed for each zone, by running RDA using CANOCO 4 (ter Braak & Smilauer, 1998) and the stats and mgcv packages of R (R Development Core Team, 2010). After the maximum explanatory power was reached, all non-significant terms were removed.

Results

Species composition. Biomass and abundance

In both areas, the retained fraction was composed of species mainly belonging to four taxonomic groups (chondrichthian and osteichthian fishes, crustaceans and cephalopods). For the coastal BI the most important discarded categories were invertebrate groups such as sponges, equinoderms, tunicates and ascidians, whereas in NC the osteichthians were the most retained and discarded category,

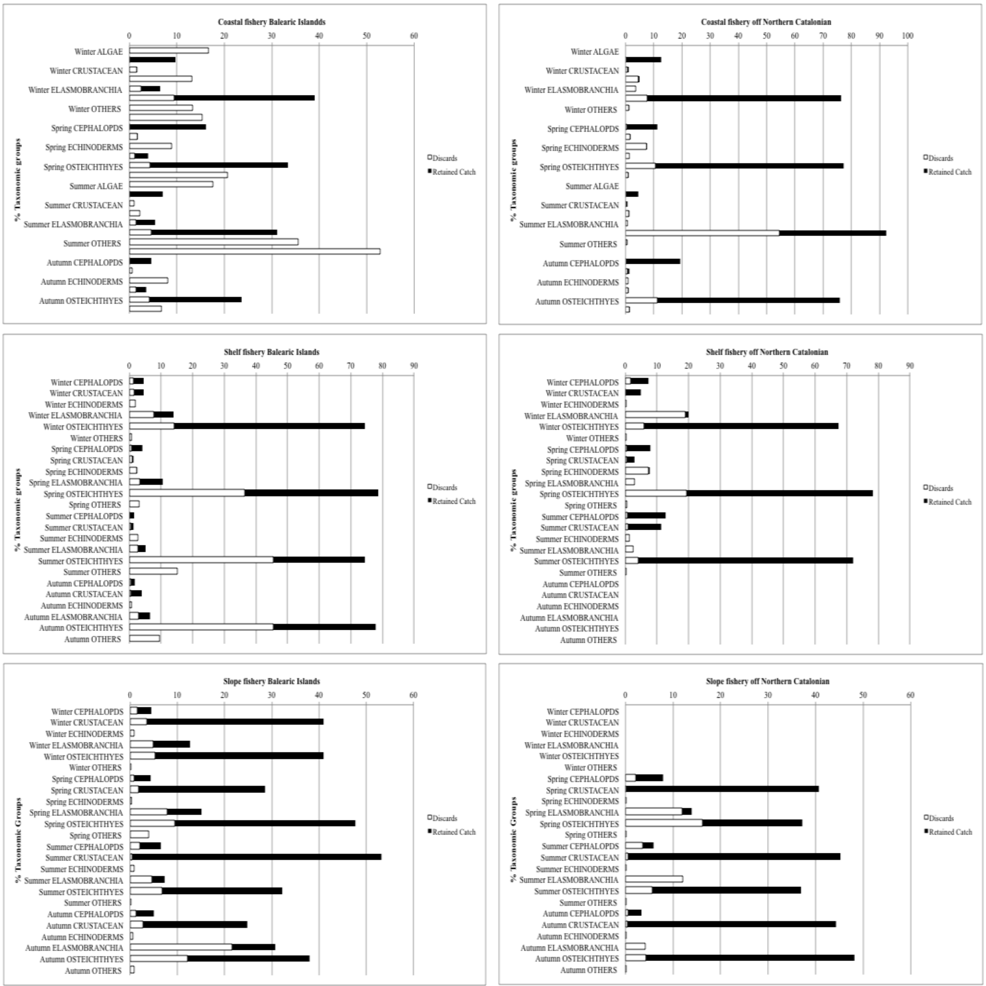


Fig. 2. Seasonal percentage of biomass by taxonomic groups and by retained and discard catch for Balearic Islands and off Northern of Catalonian for each fishing tactic (coastal, shelf, and slope).

Fig. 2. *Percentatge estacional en biomassa per grup taxonòmic per a la captura retinguda i rebutjada per a les Illes Balears i Catalunya nord per a cadascuna de les tàctiques pesqueres (costera, de plataforma i talús).*

		Balearic Islands (kg · h^{-1})			Northern Catalonia (kg · h^{-1})		
Code	**Species**	**Mean**	**CV**	**% Discard**	**Mean**	**CV**	**% Discard**
TARGET SPECIES (> 5kg h^{-1})							
P16	*Eledone cirrhosa*				6.70	18.66	0.001
P8	*M. merluccius*				16.23	7.95	0.02
P13	*M. surmuletus*	6.74	14.39	1%			
P7	*S. smaris*	6.92	21.53	12%			
COMMON BY-CATCH							
P9	*B. boops*	2.15	24.19	98%	1.33	30.83	24%
P16	**Eledone moschata*	2.14	81.31	0%	0.69	31.88	0%
P11	*L. vulgaris*	1.63	22.70	1%	1.22	25.41	1%
P12	*M. barbatus*	2.91	26.12	1%	1.78	17.42	1%
P14	** Octopus vulgaris*	4.93	34.48	0%	0.57	47.37	0.35%
P15	*P. acarne*	1.99	12.06	29%	0.96	106.25	0.21%
P5	**Sardina pilchardus*	2.27	12.78	41%	29.00	81.38	84%
P4	*S. canicula*	4.28	30.37	25%	2.21	18.10	67%
P6	*T. mediterraneus*	3.31	19.34	50%	2.25	25.78	12%
REST OF 25 MORE ABUNDANT SPECIES							
Fish + invertebrates		14.12	22.24	47%	42.30	10.78	20%
Total 25 most abundant species		50.31	10.73	42%	81.21	30.02	57%
Total general 100%		106.89	8.69	46%	147.51	24.85	44%
		Balearic Islands (N · h^{-1})			**Northern Catalonia (N · h^{-1})**		
Code	**Species**	**Mean**	**CV**	**% Discard**	**Mean**	**CV**	**% Discard**
TARGET SPECIES (> 5kg h^{-1})							
P16	*Eledone cirrhosa*				33.96	12.60	2%
P8	*M. merluccius*				236.30	9.25	19%
P13	*M. surmuletus*	110.50	21.86	0.47%			
P7	*S. smaris*	428.00	16.97	11%			
COMMON BY-CATCH							
P9	*B. boops*	91.00	31.52	98%	5.07	34.32	22%
P16	**Eledone moschata*	7.00	89.86	0%	2.79	6.45	1%
P11	*L. vulgaris*	15.00	19.87	0%	1.64	112.20	0%
P12	*M. barbatus*	162.00	21.24	4%	46.76	14.33	4%
P14	** Octopus vulgaris*	--	--	0%	1.07	34.58	0%
P15	*P. acarne*	129.53	22.68	13%	6.58	59.42	2%
P5	**Sardina pilchardus*	89.15	57.87	53%	1304.11	44.83	72%
P4	*S. canicula*	29.41	26.15	22%	10.25	27.41	97%
P6	*T. mediterraneus*	69.84	28.82	49%	132.55	26.11	18%
REST OF 25 MORE ABUNDANT SPECIES							
Fish + invertebrates		80.86	19.60	28%	1467.58	43.89	62%
Total 25 most abundant species		800.20	11.42	25%	3287.41	26.67	68%
Total general 100%		1105.23	9.69	37%	4540.55	23.50	64%

Table 2. Coastal fishery. Mean Total biomass (kg · h^{-1}) and abundance (N · h^{-1}) of the target, common by-catch and 25 main abundant species per fishing strategy. SD = Standard Deviation, CV = Coefficient of Variation., % Discard = percentage of discards in weight and number.

Taula 2. *Pesca costanera. Mitjana de la biomassa (kg · h^{-1}) i abundància (N · h^{-1}) de les espècies indicadores, comunes per captura i les 25 espècies més abundants en funció de l'estratègia de pesca. SD = Desviació estàndard, CV = Coeficient de variació, % Discard = percentatge de descart en pes i nombre.*

both in weight and abundance, for the coastal and shelf fisheries. In addition, in the NC coastal fishery crinoids colonies (*Leptometra phalagium*), in soft sandy-muddy bottoms where juvenile of hake recruit support fishery impact being discarded in big quantities. Crustaceans were the most important retained fraction in the slope fishery, both in weight and abundance, whilst chondrichthians and osteichthians were the main discarded fraction in this fishery for both areas (Fig. 2).

Percentage composition of landed and discarded fractions by target, common by-catch, and uncommon by-catch of the 25 most abundant species are shown in Tables 2, 3 and 4 by each fishing tactic and zone in biomass and abundance.

In the coastal fishery, between 10% and 11% of the total number of species accounted for 82% and 94% of the total biomass caught in the BI and NC, respectively (Table 2). Target species red mullet (*Mullus barbatus*) in BI and Horned octopus (*Eledone cirrhosa*) in NC presented similar biomass and abundance and discards under 2%; whereas species forming dense shoals like juveniles of hake (*Merluccius merluccius*) in NC, picarel (*Spicara smaris*) in BI and Mediterranean horse mackerel (*Trachurus mediterraneus*) in both zones, were discarded between 10% and 50% of their total biomass.

In the shelf fishery by the total number of species 12% and 13% accounted for 79% and 94% of the total biomass caught in the BI and NC, respectively (Table 3). They were significant differences between the two zones in space distribution for blue whiting (*Micromesistius poutassou*), greater forkbeard (*Phycis blennoides*), blackmouth catshark (*Galeus melastomus*), silvery pout (*Gadiculus argenteus*) and rockfish (*Helicolenus dactylopterus*), which preeminently have been located in the shelf in NC, but in the slope in the BI. In this fishery discards were predominantly of fish. Discards of the European hake were between 2 and 3% in biomass, but between 20 and 30% in abundance and corresponded to specimens below commercial size. Other important by-catch was blue whiting fished in low quantities, almost completely discarded in BI, whereas in NC is considered a target species, reaching high biomass, but with greater discards than others target species.

In the slope community (Table 4) the 25 most abundant species represented 22% and 26% of the total number of species, and 79% and 94% of the total biomass in the BI and NC, respectively. Red shrimp, the target species presented discards lesser than 1%, both in weight and number. Discards largely corresponded to species without commercial value and juveniles of by-catch species such as greater forkbeard and blue whiting.

Species composition biodiversity indices

A total of 270 and 237 species were caught in the coastal fishery of the BI and NC, respectively. Of these species, 96 and 61 were landed, and 174 and 176 were totally discarded in each zone. For the shelf fishery 213 and 188 species were caught by the BI and NC, respectively. Of these, 89 and 58 were landed and partially discarded, while the rest were completely discarded. In the slope fishery, 112 species were collected in the BI and 97 in the NC. Of these, 65 and 14 were landed and partially discarded, while the remainder was totally discarded. Species biodiversity indices (Table 5) showed a general trend of higher values for all indices in NC fisheries, except for the taxonomic biodiversity index (Δ^+), which was higher in the Balearic coastal fishery. The predominant pattern of biodiversity decreased with depth.

Spearman correlation coefficients (Table 6) provided a basis for grouping the 7 species biodiversity indices studied into 3 components of biodiversity: (1) number of species (S and d), (2) evenness and richness (J', H', 1-λ') and (3) taxonomic indices.

		Balearic Islands ($kg \cdot h^{-1}$)			Northern Catalonia ($kg \cdot h^{-1}$)		
Code	**Species**	**Mean**	**CV**	**% Discard**	**Mean**	**CV**	**% Discard**
TARGET SPECIES (> 5kg h^{-1})							
P8	*M. merluccius*	9.62	3%	6.60	29.55	2%	0.001
P22	*M. poutassou*			27.17	20.28	43%	0.02
P23	*N. norvegicus*	-	-	1.41	66.67	0.14%	
COMMON BY-CATCH							
P17	*A. sphyraena*	3.80	76.32	72%	0.39	33.33	2%
P19	**Lepidopus caudatus*	18.90	113.28	100%	0.91	73.63	7%
P18	*L. boscii*	3.80	20.26	6%	1.61	14.29	7%
P21	*L. budegassa*	2.18	24.77	21%	3.05	18.69	1%
P20	*L.cavillone*	2.59	25.48	76%	0.14	78.57	14%
P22	*M. poutassou*	7.46	93.57	5%			
P4	*S. canicula*	13.83	35.00	46%	1.21	55.37	100%
P6	*T. mediterraneus*	20.86	17.74	19%	0.46	52.17	0%
REST OF 25 MORE ABUNDANT SPECIES							
Fish + invertebrates		42.41	16.34	71%	18.81	12.92	26%
Total 25 most abundant species		57.48	22.15	31%	71.40	12.16	28%
Total general 100%		101.07	12.81	39%	121.28	12.36	25%
		Balearic Islands ($N \cdot h^{-1}$)			**Northern Catalonia** ($N \cdot h^{-1}$)		
Code	**Species**	**Mean**	**CV**	**% Discard**	**Mean**	**CV**	**% Discard**
TARGET SPECIES (> 5kg h^{-1})							
P8	*M. merluccius*	107.99	15.67	20%	67.46	45.70	31%
P22	*M. poutassou*				781.04	24.32	91%
P23	*N. norvegicus*				99.98	25.22	0.26%
COMMON BY-CATCH							
P17	*A. sphyraena*	560.81	83.86	59%	9.89	35.49	11%
P19	**Lepidopus caudatus*	1555.91	32.49	100%	9.68	37.60	60%
P18	*L. boscii*	10.48	18.61	13%	24.05	22.33	49%
P21	*L. budegassa*	5.40	37.04	58%	8.62	22.97	28%
P20	*L.cavillone*	65.77	19.63	84%	25.20	21.59	10%
P22	*M. poutassou*	10.40	1248.94	6%			
P4	*S. canicula*	61.19	36.39	92%	45.19	31.47	100%
P6	*T. mediterraneus*	87.17	27.20	42%	6.03	67.99	0%
REST OF 25 MORE ABUNDANT SPECIES							
Fish + invertebrates		740.17	34.60	54%	2134.61	31.33	89%
Total 25 most abundant species		983.18	47.14	60%	3269.31	21.69	40%
Total general 100%		1776.64	26.29	60%	5907.76	20.63	40%

Table 3. Shelf fishery. Mean Total biomass ($kg \cdot h^{-1}$) and abundance ($N \cdot h^{-1}$) of the target, common by-catch and 25 main abundant species per fishing strategy. SD = Standard Deviation, CV = Coefficient of Variation., % Discard = percentage of discards in weight and number.

***Taula 3**. Pesca de plataforma. Mitjana de la biomassa ($kg \cdot h^{-1}$) i abundància ($N \cdot h^{-1}$) de les espècies indicadores, comunes per captura i les 25 espècies més abundants en funció de l'estratègia de pesca. SD = Desviació estàndard, CV = Coeficient de variació., % Discard = percentatge de descart en pes i nombre.*

Code	Species	Balearic Islands (kg · h^{-1}) Mean	CV	% Discard	Northern Catalonia (kg · h^{-1}) Mean	CV	% Discard
TARGET SPECIES (> 5kg h^{-1})							
P24	*A. antennatus*	5.06	10.28	0%	5.21	25.53	0%
COMMON BY-CATCH							
P25	C. conger	0.23	21.74	22%	0.42	69.05	2%
P26	*Etmopterus spinax*	0.10	20.00	100%	0.22	27.27	100%
P27	*G. melastomus*	2.12	20.28	84%	1.05	48.57	70%
P19	*L. caudatus*	0.36	55.56	100%	0.11	27.27	100%
P18	*L. boscii*	1.04	19.23	6%	0.04	150.00	0%
P21	*L. budegassa*	1.13	32.74	2%	0.69	89.86	0.14%
P28	*L. crocodilus*	0.20	20.00	100%	0.64	45.31	100%
P8	*M. merluccius*	1.05	19.05	0%	0.97	30.93	0.10%
P22	*M. poutassou*	2.26	24.34	0%	0.34	23.53	2%
P29	*N. aequalis/ sclerorhynchus*	0.25	20.00	100%	0.04	50.00	100%
P31	*P. blennoides*	3.18	15.09	8%	1.55	14.84	4%
P30	*P. cuvieri*	0.37	13.51	4%	0.10	40.00	0%
P4	**S. canicula*	0.68	164.71	41%	0.04	100.00	100%
P32	*T. sagittatus*	0.75	26.67	5%	0.16	50.00	4%
REST OF 25 MORE ABUNDANT SPECIES							
Fish + invertebrates		10.39	21.17	35%	1.25	15.20	34%
Total 25 most abundant species		21.12	12.88	20%	10.37	14.18	25%
Total general 100%		20.67	16.69	28%	12.22	14.41	22%

Code	Species	Balearic Islands (kg · h^{-1}) Mean	CV	% Discard	Northern Catalonia (kg · h^{-1}) Mean	CV	% Discard
TARGET SPECIES (> 5kg h^{-1})							
P24	*A. antennatus*	230.51	16.01	0%	86.38	18.19	0%
COMMON BY-CATCH							
P25	C. conger	0.69	50.72	58%	2.20	29.55	3%
P26	*Etmopterus spinax*	3.57	22.41	91%	2.86	25.52	100%
P27	*G. melastomus*	26.42	26.19	78%	5.96	33.56	91%
P19	*L. caudatus*	3.89	89.97	100%	0.88	44.32	100%
P18	*L. boscii*	4.74	25.74	14%	1.02	38.24	13%
P21	*L. budegassa*	0.91	28.57	14%	0.32	90.63	0%
P28	*L. crocodilus*	14.49	26.92	100%	41.00	39.41	100%
P8	*M. merluccius*	1.87	39.04	5%	0.89	33.71	15%
P22	*M. poutassou*	19.86	24.32	2%	5.07	24.46	4%
P29	*N. aequalis/ sclerorhynchus*	5.92	46.28	100%	4.96	51.21	100%
P31	*P. blennoides*	39.35	21.63	35%	13.21	32.10	22%
P30	*P. cuvieri*	0.92	4.35	13%	0.02	100.00	0%
P4	**S. canicula*	21.88	40.68	47%	0.11	100.00	100%
P32	*T. sagittatus*	1.25	16.00	21%	0.36	47.22	11%
REST OF 25 MORE ABUNDANT SPECIES							
Fish + invertebrates		133.72	21.78	42%	103.29	30.38	22%
Total 25 most abundant species		373.14	11.78	30%	289.24	16.37	33%
Total general 100%		456.29	15.19	29%	292.57	46.25	38%

Table 4. Slope fishery. Mean Total biomass (kg · h^{-1}) and abundance (N · h^{-1}) of the target, common by-catch and 25 main abundant species per fishing strategy. SD = Standard Deviation, CV = Coefficient of Variation., % Discard = percentage of discards in weight and number.

***Taula 4**. (página anterior) Pesca de talús. Mitjana de la biomassa (kg · h^{-1}) i abundància (N · h^{-1}) de les espècies indicadores, comunes per captura i les 25 espècies més abundants en funció de l'estratègia de pesca. SD = Desviació estàndard, CV = Coeficient de variació., % Discard = percentatge de descart en pes i nombre.*

The Spearman rank correlation matrix for each data set split the indices into two groups: a first group showed high correlation of species indices, and evenness indices and among them (R^2 = between 0.84 and 0.92), while the second group differentiated indices that corresponded to the taxonomic descriptors (R^2 = between 0.36 and 0.52). Spearman rank correlation confirmed that primary indices were weakly correlated with taxonomic indices (R^2 = between -0.04 and -0.20). Index values revealed that high biodiversity corresponded to hauls where numerous taxonomic groups were present, or alternatively hauls where fish species in number and abundance predominate in the catches.

Balearic Islands 1994-1996 Fishery depth m.	Coastal 38 - 162	Shelf 64 - 364	Slope 374 - 787
S	70.33 (±11.70)	57.71 (±11.07)	52.8 (2.95)
d	6.20 (±1.67)	5.74 (±1.37)	5.76 (±1.58)
J'	0.57 (±0.15)	0.64 (±0.10)	0.48 (±0.17)
H'	2.17 (±0.60)	2.37 (±0.39)	1.72 (±0.68)
1-λ'	0.76 (±0.18)	0.84 (±0.097)	0.66 (±0.22)
Δ*	90.11 (±8.26)	81.64 (±7.34)	83.51 (±8.07)
Δ^+	91.69 (±2.67)	88.72 (±3.14)	90.42(±1.18)
$TL_{Biomass}$	2.93 (±0,30)	3.53 (±0,16)	3.70 (±0,13)
$TL_{Abundance}$	3,45 (±0,21)	3.34 (±0,14)	3.64 (±0,11)
Northern Catalonia 1998- 2000 Fishery depth m.	50 - 150	90 - 415	300 - 600
S	46.56 (±11.10)	40.93 (±8.73)	36.80 (±10.05)
d	14.15 (±2.04)	12.53 (±2.09)	9.33 (0.90)
J'	0.91 (±0.015)	0.90 (±0.020)	0.57 (0.04)
H'	3.89 (±0.19)	3.65 (±0.20)	2.25 (0.15)
1-λ'	0.98 (±0.005)	0.98 (±0.006)	0.80 (0.03)
Δ*	92.65 (±1.11)	91.06 (±1.90)	87.48 (4.10)
Δ^+	90.91 (±1.44)	92.01 (±1.90)	90.66 (1.27)
$TL_{Biomass}$	3.09	2.85	3.55
$TL_{Abundance}$	3.51	3.59	3.70

Table 5. Diversity indices for the Balearic Islands and Northern Catalonia (Gulf of Lion). S = average number of species by haul; d = Margalef index (Richness); J'= Pielou index (Evenness); H' (log e) = Shannon and Wiener index (Diversity index); 1-λ' = Simpson index; Δ* =Taxonomic Distinctness; TL = Trophic Level.

***Table 5.** Índex de biodiversitat de les Illes Balears i el Nord de Catalunya (Golf de Lleó). S = mitjana del nombre d'èspecies per captura; d = índex de Margalef (riqueza); J' = índex de Pielou (uniformitat); H' (log e) = índex de Shannon i Wiener (índex de diversitat); 1-λ' = índex de Simpson; Δ* =Diferència taxonòmica; TL = nivell tròfic.*

			BALEARIC ISLANDS				
GROUP A	S	d	J'	H'	1-λ'	Δ^+	Δ*
S	1.00						
d	0.84	1.00					
J'	0.04	0.18	1.00				
H'	0.41	0.47	0.90	1.00			
1-λ'	0.28	0.34	0.88	0.92	1.00		
Δ^+	-0.31	-0.29	-0.34	-0.44	-0.47	1.00	
Δ*	0.36	0.54	**-0.20**	**-0.04**	**-0.15**	0.23	1.00
GROUP B							
S	1.00						
d	0.86	1.00					
J'	-0.21	**0.05**	1.00				
H'	0.22	0.40	0.88	1.00			
1-λ'	**0.05**	0.24	0.92	0.95	1.00		
Δ^+	0.16	**0.09**	-0.17	**-0.10**	-0.16	1.00	
Δ*	0.52	0.39	-0.39	**-0.10**	**-0.12**	0.29	1.00
GROUP C							
S	1.00						
d	0.84	1.00					
J'	0.42	0.44	1.00				
H'	0.55	0.54	0.98	1.00			
1-λ'	0.50	0.49	0.98	0.98	1.00		
Δ^+	**0.03**	0.15	0.31	0.29	0.23	1.00	
Δ*	0.33	0.37	0.31	0.35	0.33	0.14	1.00
			NORTHERN CATALONIA				
GROUP A	S	d	J'	H'	1-λ'	Δ^+	Δ*
S	1.00						
d	0.94	1.00					
J'	0.52	0.67	1.00				
H'	0.63	0.76	0.98	1.00			
1-λ'	0.52	0.65	0.98	0.97	1.00		
Δ^+	-0.20	-0.21	-0.28	-0.31	-0.33	1.00	
Δ*	0.32	0.25	**0.07**	**0.13**	**0.08**	-0.30	1.00
GROUP B							
S	1.00						
d	0.83	1.00					
J'	0.30	0.59	1.00				
H'	0.38	0.62	0.99	1.00			
1-λ'	0.32	0.56	0.98	0.99	1.00		
Δ^+	0.14	**0.01**	-0.48	-0.43	-0.47	1.00	
Δ*	0.11	**0.04**	-0.12	**-0.07**	**-0.12**	0.14	1.00
GROUP C							
S	1.00						
d	0.37	1.00					
J'	-0.58	0.30	1.00				
H'	-0.37	0.60	0.90	1.00			
1-λ'	-0.95	-0.50	0.30	**0.10**	1.00		
Δ^+	0.21	0.80	**0.00**	0.40	-0.20	1.00	
Δ*	0.32	**-0.10**	-0.60	-0.70	**-0.10**	**-0.10**	1.00

Table 6. Spearman rank correlation coefficients calculated between all species' diversity descriptors considered. All correlations are significant with $p < 0.05$, except for values in bold. The Spearman coefficient distribution under null hypothesis was approximated by a normal distribution with mean equal to 0 and standard deviation equal to $1/\sqrt{(n+1)}$.

Taula 6. *(pàgina anterior) Coeficients de correlació d'Sperman entre espècies i els descriptors considerats. Totes les correlacions són significatives amb una $p < 0.05$, excepte per als valors en negreta. La distribució dels coeficients d'Spearman sota la hipòtesi nul·la és aproximadament una distribució normal amb la mitjana igual a 0 i la desviació standard igual a $1/\sqrt{(n+1)}$.*

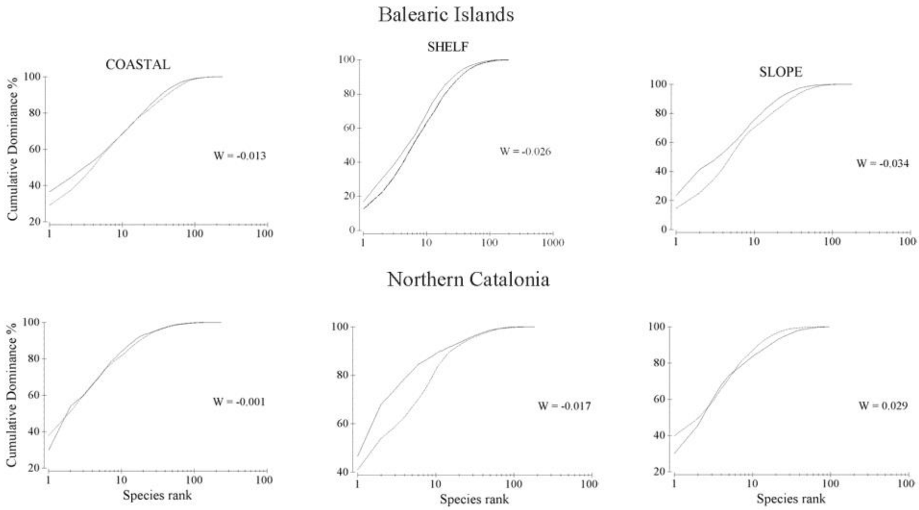


Fig. 3. *k*- Dominance accumulative curves (abundance-biomass) per species of Balearic Islands and off Northern Catalonia by each fishing tactics.
Fig. 3. *k- Corbes de dominància acumulativa (abundància-biomassa) a les Illes Balears i a Catalunya nord per a cadascuna de les tàctiques pesqueras.*

Richness and evenness biodiversity estimates calculated in this study for the two zones showed small differences between more and less productive zones. A comparison of the number of species indicated a greater absolute biodiversity for the BI, with a major number of different species and taxonomic groups, whilst in NC the major abundances of a great number of species gave estimations of higher richness and evenness indices. Comparing the two areas, the taxonomic distinctness (higher for coastal fishery in the BI and for shelf fishery in NC) appeared slightly negatively related to discards.

The trophic level was similar for the more abundant captured species in both zones, in all likelihood more related to the fishery's preference of species than to the trophic level of the exploited communities. Even if there are several limitations to assigning a single trophic level by species, without taking into account that trophic levels are size-dependent, here the comparison was possible because in both areas the Mediterranean trawl harvest the youngest fish ages (mainly ages 0+, 1+).

The *k*-dominance curves (Fig. 3) showed that the proximity of abundance and biomass curves indicated a very moderate disturbance for coastal fisheries (W = - 0.01 and -0.001 for the BI and NC respectively). Shelf fisheries displayed slightly higher negative values of W statistics in both zones (W= - 0.026, and - 0.017); after removing the first ranked species, using partial dominance curves, the biomass showed the abundance line above biomass.

Thus, the *k*-dominance curve seemed to indicate dominance of small epi-mesopelagic species in this fishery. In the slope fishery, abundance was slightly above the biomass curve in the BI (W = -0.034), whilst in NC, appeared above of the abundance curve (W = 0.029). Further evidence of a more impacted zone in the BI slope fishery was obtained when comparing the weight and abundance of red shrimp in the BI with 45 as opposed to 17 individuals per kg in average off NC (see Table 4).

Seasonal retained and discarded yields

In the coastal and shelf fisheries , the highest average biomass for retained and discards catches were recorded in summer in NC and winter in the BI , whereas in abundance was in in spring and summer for NC and winter, and autumn for retained and summer and autumn for discarded in BI respectively. For the slope fishery maximum biomass and abundance values for retained were recorded in spring for NC and autumn and winter for BI.

In BI silver scabbardfish (*Lepidopus caudatus*) and bogue (*Boops boops*) were the main species discarded in biomass for the shelf fishery, with boarfish (*Capros aper*) in abundance. In the NC coastal fishery, pilchard (*Sardina pilchardus*) in biomass in summer and *Leptometra phalangium* (Echinodermata: Crinoidea) in spring represented the highest discards in biomass and abundance, respectively. To a lesser extent, blue whiting and European hake also contributed to the discards in abundance in the NC shelf fishery.

Discards patterns

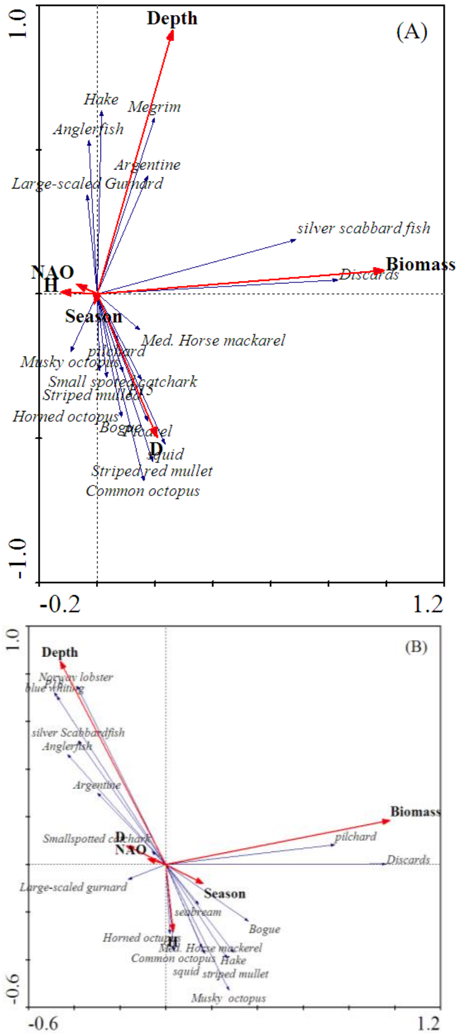
For visualization purposes only the biplot obtained through the RDA model are shown for the coastal and shelf fisheries together (Fig. 4). The response variables were the target and by-catch most abundant species. Species yields were predicted to increase in the direction

Balearic Islands	**All fisheries together**		**Coastal, shelf and shelf-break fisheries**	
	Axis I	Axis II	Axis I	Axis II
Eigenvalue	0.25	0.03	0.17	0.04
Eigenvalue as % of total variation	25%	3%	17%	4%
Eigenvalue as cumulative % of total variation	25%	28%	17%	21%
Eigenvalue as % sum of all canonical eigenvalues	73%	10%	64%	17%
Eigenvalue as cumulative % sum of all canonical eigenvalues	73%	82%	64%	81%
Northertn Catalonia	**All fisheries together**		**Coastal, shelf and shelf-break fisheries**	
	Axis I	Axis II	Axis I	Axis II
Eigenvalue	0.27	0.06	0.34	0.06
Eigenvalue as % of total variation	27%	6%	34%	6%
Eigenvalue as cumulative % of total variation	27%	33%	34%	0.40
Eigenvalue as % sum of all canonical eigenvalues	72%	15%	74%	13%
Eigenvalue as cumulative % sum of all canonical eigenvalues	72%	82%	74%	87%

Table 7. Numerical output for RDA for significant explanatory variables.
***Taula** 7. Resultat de RDA per a les variables explicatives significatives.*

Fig. 4. RDA biplot of species and environment variables. (A) Balearic Islands, and (B) Northern Catalonian. The first two axis of the final triplot explain 82% and 89% of the total sum of all canonical eigenvalues respectively. Explanatory variables: Depth, season, seasonal NAO index, Shannon (H), Distinctness (D), diversity indices and Total Biomass.

Fig. 4. *RDA biplot de les espècies més abundants i les variables ambientals. El dos primers eixos expliquen el 82 i el 89% de la suma total de tots els valors propis canònics. Variables explicatives foren: Fondària, estacionalitat, Índex estacional NAO, Shannon (H) i taxonòmic distintivitat (D), índexs de diversitat Biomassa total.*



indicated by the arrow of a particular explanatory variable. Explanatory variables used for the final run were the follows: depth, season, taxonomic distinctiveness (D), and total biomass (the rest of variables although not significant were also drawn in figures). The numerical output of RDA (Table 7) showed that all explanatory variables explained 82% of the total sum of all canonical eigenvalues and 21% of the total variation of the species and discard data for the BI, and 87% and 34% for NC, respectively. The first two axes were determined positively by biomass and discards (first axis) and depth (second axis) (p = 0.000) for both zones. Season, in NC was significant, and represented between the positive first axis and negative second axis, explaining 10% of the variance (F-ratio = 3.54, p = 0.0041). In contrast was not significant for BI, explaining 5% of the variance. Taxonomic diversity proved to be significant in BI (F-ratio = 4.15, p = 0.001) and not in NC (Table 8). The discard was positively correlated with the shelf fishery in the BI, and with the coastal fishery of NC (figures not shown).

In BI species discards more correlated with total biomass and discards was silver scabbard fish, species presented in dense patchy shoals always completely discarded; species highly correlated with distinctiveness were mullets, octopuses and squid with reduced or null discards, and Picarel, Mediterranean horse mackerel, spoted small catshark species partially discarded, and bogue almost totally discarded. Species correlated with depth were European hake, and Megrim, highly commercialised and with null o very low discards and Anglerfish and Argentine with high and low commercial values respectively and partially discarded and Large-scaled Gurnard mainly discarded. Almost all species appeared in the biplot were centered, because silver scabbard fish

Component	Explanatory variables	SCE.	Var.	%
Balearic Islands				
All fisheries				
Season	Season	0.03	0.03	3%
Other explanatory variables	Depth; Δ*; Biomass	0.34	0.31	31%
Season with other as covariate		0.03		
Other with season as covariate		0.31		
All explanatory variables		0.34		
Shared			0	0%
Residual			0.66	66%
Coastal, Shelf and Shekf-break fisheries				
Season	Season	0.05	0.05	5%
The other explanatory variables	Depth; Δ*; Biomass	0.26	0.21	21%
Season with the others as covariate		0.05		
The others with season as covariate		0.21		
All explanatory variables		0.26		
Shared			0	0%
Residual			0.74	74%
Total			1	100%
Northern Catalonia				
All Fisheries				
Season	Season	0.11	0.07	7%
The others explanatory variables	Depth; Biomass	0.42	0.31	31%
Season with the others as covariate		0.07		
The others with season as covariate		0.31		
All explanatory variables		0.42		
Shared			0.03	3%
Residual			0.58	58%
Total			1	100%
Coastal, Shelf and Shelf-break fisheries				
Season	Season	0.15	0.10	10%
The others explanatory variables	Depth; Biomass; Season as variable	0.49	0.34	34%
Season with the others as covariate		0.1		
The others with season as covariate		0.34		
All explanatory variables		0.49		
Shared			0.05	5%
Residual			0.51	51%

Table 8. Results of various RDA analysis and Variance partioning in RDA. The total variation of the species' data is scaled to 1. SCE, Sum of All Canonincal Eigenvalues. Var, variance.

Taula 8. *Resultats de les anàlisis RDA i de partició de la variància. La variació total de les dades d'espècies s'ha rescalat en base 1. SCE, suma dels vectors principals canònics. Var, variància.*

presented a marked patchy distribution, and the other species were sorted in the depth gradient. In NC, the biplot showed pilchard like scabbard fish, fished in dense patchy shoals, it was the species more correlated with biomass and also with discards. In the negative side of the second axis were found bogue, seabreams, octopuses and squid, Mediterranean horse mackerel and stripped mullets. This second axis was defined positively by depth and negatively by seasonality. The assemblage of species in the second axis in their negative side includes highly commercialized species, with low discards, and species with medium and low commercial value partially discards, but with low seasonal fluctuations. In the positive side of the second axis were found Norway lobster, blue-whiting, Anglerfish and silver Scabbard fish. Their biomass and abundance increased with depth, and they are highly valuable commercialised species partially discards. The small catshark appeared centred and highly correlated with distinctiveness. Species that contributed more to the discards were pilchard, European hake, Mediterranean horse mackerel, and bogue.

Discussion

The composition of the different groups inpercentage barely differs between zones, except for chondrichthians, which represented 10% of the entire fish group in the Balearics. The spatial habitat could have a special significance for this group, as pointed out by Damalas and Vassilopoulou (2011) in the Aegean Sea.

Average biodiversity values by fishing tactic were similar in both zones and are comparable to the indices obtained in studies carried out in the Western Mediterranean during the nineties (Aldebert, 1997; Moranta *et al*., 2000; Sánchez *et al*., 2004). The fishing tactics studied presented significant decreasing biodiversity trends by depth, which is also well known in the Western and Eastern Mediterranean (Stergiou *et al*., 1998; Machias *et al*., 2001; Sánchez *et al*., 2004; Tsagarakis, 2008). The *k*- biomass abundance drawn by fishery tactic showed similar patterns in both areas, shelf in both zones and slope in the Balearics seemed to sustain more impact.

Variations caused by seasonal and inter-annual environmental conditions may influence the discards of species although they didn't reach significance, for e.g. the NAO index corresponded to a negative period for the Balearic Islands but positive for NC. The influence of this index came close to being significant for the BI, but was negligible for NC. In the BI the effect of a negative NAO index in the distribution and abundance of the species may be associated with more productive periods in this zone (Massutí *et al*., 2008) and therefore it may imply more discards. The low influence of the NAO index in NC may be explained by the low contrast of the index throughout the periods studied; it correspond to positive indices associated to dry periods that can reduce the extent of the recruitment phenomena (Lloret *et al*., 2000), which has been related to lower discards.

Seasonality showed for almost all tactics a delay in the discards maximums between the two zones (Bakun and Agostini, 2001), which result in maximum discard levels recorded approximately one season later in the BI. Thus, higher spring and summer productivity in NC increase discards in summer, while maximum productivity reaches the BI by the autumn and winter.

The results of the RDA indicated that discarding was closely related to the biomass harvested. In NC, seasonal variability was significantly influential, whereas in the BI, the percentage of variation that explains the second axis was more associated with the characteristics of the biocenoses. This concurs with the fact that primary production in NC is the main driving force behind the ecosystem, since it is heavily influenced by coastal upwelling and land runoff discharges (Gaertner *et al.*, 1999), supporting bigger quantities of pelagic and epi-benthopelagic species, with seasonal fluctuations (Palomera, 1992). In contrast, the coastal Balearic system is associated to suspensivorous feeders, such as sponges, ascidians, and hydroids, which are totally discarded together with calcareous rodophyte algae (Ordines *et al.*, 2009). Management regulations may also intensify the reason for discards in NC since regulation only allows landing of 10% of pelagic species, such as pilchard or anchovy, by vessel and trip.

The highest pelagic catch typically occurs during its reproduction period or during the recruitment to the gear (Aldebert and Tournier, 1971) increasing in these periods discards rates and producing retained and discards variations, due to spatial and seasonal abundances (Lloret *et al.*, 2001; 2004). Whilst in the BI discards showed similar values along the year probably due to their higher dependence on species that are permanent part of the biocenoses (Ballesteros, 1994; Barberà *et al.*, 2003).

The most significant difference for target species was found in the coastal fishery with the European hake, one of the most economically important and exploited species of the Mediterranean Sea, presenting dense concentrations of juveniles in shallow and shelf waters off NC (Maynou *et al.*, 2003) what was not found in the Balearics. This species trend to repeat the locations of the nursery areas in the Gulf of Lions, and strong connections were found between the amplitude of nursery areas and the abundances of juveniles in the fishery captures (Abella *et al.*, 2005).

Mediterranean trawl fisheries are mainly characterized by the presence of a large variety of species and the absence of large monospecific stocks. The ability of species with higher reproductive rates to replenish themselves is one of the community responses to disturbance, such as fishing. On the other hand, the complexity of the structure of the community and substratum (rocks, sponges, etc.), enhance growth and reduce the risk of predation, which may have implications for the recoverability of species (Sainsbury, 1988). In this sense, NC may be considered as holding size-structured community where the number of species with higher reproductive rates allows maintain the harvest, whereas the original coastal habitat of the BI have positive repercussions for the maintenance of the species.

By bearing in mind the characteristics of each zone and by including information on hotspot biodiversity and recruitment zones in the framework of planning protection figures (such as marine protected areas (MPAs) or temporal closures), positive and negative management measures, and fishing technology improvements may reduce the discards. However, until now discards are produced by management rules (commercialized sizes), and driven by market requirements.

This study depicted the trawl fishery scenario in the past decade, when the rhombic 40 mm mesh size was in use. In the present the discards rates should have been reduced by the change in the mesh size to a 40 mm square diameter or 50 mm diamond diameter. In summary, regardless the present management model, the market preferences and biological and environmental processes continue defining the fishery discards and catches. We demonstrate that differences between zones and environment and biological processes have importance in discards impacts and are key factors to understand how to reduce discards. By delimiting these areas of complex biocenosis structures and recruitment zones, and sensitive seasons to discards increases, as accuracy as possible, may allow a new management scenario adapted to each zone of reduced discards.

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